Supporting Information

**Palladium-Catalyzed Highly Selective and Direct Ortho C–H Arylation of Pyrrolo[2,3-d]pyrimidine Derivatives**

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1. General Information

Chemicals were purchased from commercial suppliers and used as delivered. Deuterated solvents were purchased and used without further purification. NMR spectra were obtained on a Bruker ADVANCE III 500 MHz with TMS as the internal standard and CDCl3 as the solvent. Chemical shifts are given in parts per million (ppm) and coupling constants in Hz. In the 1H and 13C spectra, chemical shifts are reported relative to deuterated solvents (CDCl3: 7.26/77.2 ppm). The following abbreviations were used for 1H NMR to indicate the signal multiplicity: s (singlet), d (doublet), t (triplet), m (multiplet), br s (broad singlet). Melting points were measured on a BUCHI B-540 and uncorrected. FT-IR were recorded on a Bruker Tensor 27 spectrometer. Analytical thin-layer chromatography was carried out using commercial aluminum sheets precoated (0.2 mm layer thickness) with silica gel GF254, and visualization was effected with short wavelength UV light (254 nm). HRMS (ESI) were determined on a Therm LCQ TM Deca XP plus spectrometer. Product purification by flash chromatography was performed using 200-400 mesh silica gel.
2. Condition Optimization

Table S1. Condition optimization

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<tr>
<th>Entry</th>
<th>Catalyst (mol%)</th>
<th>Temp. (°C)</th>
<th>PhI(OAc)₂, PhB(OH)₂ (equiv.)</th>
<th>Solvent</th>
<th>Time (h)</th>
<th>Yield (%)&lt;sup&gt;b&lt;/sup&gt;</th>
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<td>AcOH</td>
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<td>NR</td>
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<sup>a</sup>0.4 mmol scale. <sup>b</sup>Isolated yields.
3. General Procedures for Pd-Catalyzed Arylation

(1) General Procedure A for Mono-Arylation Using Symmetrical Arylating Agents

The reaction of 7-methyl-4-[(1,1'-biphenyl)-2-yl]-7H-pyrrolo[2,3-d]pyrimidine 2aa was exemplified here. Diacetoxyiodobenzene (258 mg, 0.8 mmol), phenylboronic acid (98 mg, 0.8 mmol) and AcOH (2.5 mL) were added in a pressure vessel. The reaction mixture was stirred at 80 °C for 1 h. This was followed by the addition of 7-methyl-4-phenyl-7H-pyrrolo[2,3-d]pyrimidine 1a (84 mg, 0.4 mmol) and Pd(OAc)$_2$ (4.5 mg, 0.02 mmol) to the above reaction mixture. It was stirred at 80 °C for 2 h. After completion of the reaction, it was then cooled to room temperature, extracted with DCM (3×50 mL) and washed with water (30 mL), saturated sodium bicarbonate (30 mL) and brine (50 mL) before the organic phase was dried over anhydrous Na$_2$SO$_4$ and concentrated in vacuo. The residue was purified by column chromatography (PE/EtOAc = 4:1) on silica gel to provide the desired product 7-methyl-4-[(1,1'-biphenyl)-2-yl]-7H-pyrrolo[2,3-d]pyrimidine 2aa (100.3 mg, 88% yield).

(2) General Procedure B for Mono-Arylation Using Unsymmetrical Arylating Agents
The reaction of 7-methyl-4-(4'-methyl-[1,1'-biphenyl]-2-yl)-7$H$-pyrrolo[2,3-$d$]pyrimidine 3aa was exemplified here. 2,4,6-Trimethyl(diacetoxyiodo)benzene (291 mg, 0.8 mmol), 4-tolylboronic acid (109 mg, 0.8 mmol) and AcOH (2.5 mL) were added in a pressure vessel. The reaction mixture was stirred at 100 °C for 1 h. This was followed by the addition of 7-methyl-4-phenyl-7$H$-pyrrolo[2,3-$d$]pyrimidine 1a (84 mg, 0.4 mmol) and Pd(OAc)$_2$ (4.5 mg, 0.02 mmol) to the above reaction mixture. It was stirred at 100 °C for 12 h. After completion of the reaction, it was then cooled to room temperature, extracted with DCM (3×50 mL) and washed with water (30 mL), saturated sodium bicarbonate (30 mL) and brine (50 mL) before the organic phase was dried over anhydrous Na$_2$SO$_4$ and concentrated in vacuo. The residue was purified by column chromatography (PE/EtOAc = 4:1) on silica gel to provide the desired product 7-methyl-4-(4'-methyl-[1,1'-biphenyl]-2-yl)-7$H$-pyrrolo[2,3-$d$]pyrimidine 3aa (91 mg, 76% yield).
4. Characterization of Compounds 2, 3, 4a-4c

7-methyl-4-([(1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2aa)

Yellow solid (100.4 mg, 88% yield). Mp: 96−98 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.86 (s, 1H), 7.65 (d, J = 7.5 Hz, 1H), 7.51 (m, 2H), 7.46 (m, 1H), 7.14 (m, 2H), 7.11−7.07 (m, 3H), 6.92 (d, J = 3.6 Hz, 1H), 6.03 (d, J = 3.6 Hz, 1H), 3.75 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 159.4, 151.2, 150.6, 141.0, 140.9, 136.8, 130.6, 130.5, 129.2, 129.0, 127.9, 127.3, 126.5, 117.4, 100.0, 30.9. HRMS m/z (ESI): calcd for C₁₉H₁₆N₃ [M+H]⁺: 286.1339, found: 286.1351.

7-propyl-4-([(1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2ab)

Yellow viscous oil (109.9 mg, 88% yield). ¹H NMR (500 MHz, CDCl₃) δ 8.85 (s, 1H), 7.67 (d, J = 7.1 Hz, 1H), 7.53−7.49 (m, 2H), 7.47−7.44 (m, 1H), 7.14 (m, 2H), 7.10−7.06 (m, 3H), 6.92 (d, J = 3.6 Hz, 1H), 6.01 (d, J = 3.6 Hz, 1H), 4.13 (t, J = 7.2 Hz, 2H), 1.84−1.76 (m, 2H), 0.83 (t, J = 7.3 Hz, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 159.3, 151.0, 150.4, 141.0, 140.9, 136.9, 130.5, 130.3, 129.1, 128.9, 128.1, 127.7, 127.2, 126.4, 117.4, 99.9, 45.9, 23.3, 11.0. HRMS m/z (ESI): calcd for C₂₁H₁₉N₃Na [M+Na]⁺: 336.1471, found: 336.1478.

7-tosyl-4-([(1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2ac)
Yellow solid (146.4 mg, 86% yield). Mp: 185–187 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 9.01 (s, 1H), 8.00 (d, \(J = 7.9\) Hz, 2H), 7.60 (d, \(J = 7.5\) Hz, 1H), 7.56–7.52 (m, 2H), 7.47 (d, \(J = 7.5\) Hz, 1H), 7.43 (d, \(J = 3.9\) Hz, 1H), 7.29 (d, \(J = 8.1\) Hz, 2H), 7.10 – 7.03 (m, 5H), 6.07 (d, \(J = 3.9\) Hz, 1H), 2.38 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 160.7, 153.0, 150.8, 145.5, 140.9, 140.1, 135.6, 134.6, 130.5, 130.4, 129.7, 129.6, 128.9, 128.0, 127.9, 127.4, 126.7, 126.0, 119.3, 104.2, 21.4. HRMS m/z (ESI): calcd for C\(_{25}\)H\(_{19}\)N\(_3\)O\(_2\)SNa \([M+Na]^+\): 448.1090, found: 448.1097.

7-benzyl-4-([1,1'-biphenyl]-2-yl)-7\(^H\)-pyrrolo[2,3-\(d\)]pyrimidine (2ad)

Yellow solid (124.6 mg, 86% yield). Mp: 157–159 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.95 (s, 1H), 7.75 (m, 1H), 7.60–7.54 (m, 2H), 7.54–7.50 (m, 1H), 7.33–7.25 (m, 3H), 7.22–7.17 (m, 2H), 7.17–7.11 (m, 3H), 7.11–7.06 (m, 2H), 6.92 (d, \(J = 3.6\) Hz, 1H), 6.08 (d, \(J = 3.6\) Hz, 1H), 5.40 (s, 2H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 159.7, 151.5, 150.7, 141.1, 141.0, 136.9, 136.8, 130.6, 130.4, 129.2, 129.1, 128.6, 128.1, 127.9, 127.7, 127.3, 127.2, 126.5, 117.4, 100.7, 47.6. HRMS m/z (ESI): calcd for C\(_{25}\)H\(_{20}\)N\(_3\) [M+H]^+: 362.1652, found: 362.1657.

7-SEM-4-([1,1'-biphenyl]-2-yl)-7\(^H\)-pyrrolo[2,3-\(d\)]pyrimidine (2ae)

Yellow viscous oil (120.3 mg, 75% yield). \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.89 (s, 1H), 7.69 (dt, \(J = 7.6, 1.0\) Hz, 1H), 7.54 (dd, \(J = 5.0, 1.1\) Hz, 2H), 7.49 (m, 1H), 7.16–7.13
(m, 2H), 7.12–7.06 (m, 4H), 6.07 (d, J = 3.6 Hz, 1H), 5.57 (s, 2H), 3.45 (t, J = 8.1 Hz, 2H), 0.88 (t, J = 8.2 Hz, 2H), −0.07 (s, 9H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 159.8, 151.7, 151.3, 141.1, 140.9, 136.8, 130.6, 130.5, 129.3, 129.1, 127.9, 127.4, 126.6, 117.5, 101.4, 72.6, 66.2, 17.6, -1.5. HRMS m/z (ESI): calcd for C$_{24}$H$_{28}$N$_3$OSi [M+H]$^+$: 402.1996, found: 402.2002.

7-methyl-4-(5-methyl-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2ba)

Yellow viscous oil (90.5 mg, 76% yield). $^1$H NMR (500 MHz, CDCl$_3$) δ 8.86 (s, 1H), 7.57 (d, J = 7.8 Hz, 1H), 7.36 (s, 1H), 7.30 (d, J = 7.8 Hz, 1H), 7.18–7.13 (m, 2H), 7.13–7.08 (m, 3H), 6.90 (d, J = 3.5 Hz, 1H), 6.04 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H), 2.47 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 159.6, 151.3, 150.6, 141.1, 140.9, 139.2, 134.1, 131.3, 130.7, 129.1, 128.1, 127.9, 126.5, 117.4, 100.2, 31.0, 21.3. HRMS m/z (ESI): calcd for C$_{20}$H$_{18}$N$_3$ [M+H]$^+$: 300.1495, found: 300.1506.

7-methyl-4-(5-(tert-butyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2bb)

Yellow solid (118.3 mg, 87% yield). Mp: 162–164 °C $^1$H NMR (500 MHz, CDCl$_3$) δ 8.84 (s, 1H), 7.62 (d, J = 8.0 Hz, 1H), 7.55–7.50 (m, 2H), 7.19–7.16 (m, 2H), 7.15–7.10 (m, 3H), 6.92 (d, J = 3.6 Hz, 1H), 6.08 (d, J = 3.6 Hz, 1H), 3.79 (s, 3H), 1.41 (s, 9H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 159.7, 152.4, 151.4, 150.8, 141.7, 140.7, 134.2, 130.6, 129.2, 129.0, 128.0, 127.8, 126.5, 124.5, 117.5, 100.3, 34.8, 31.3, 31.0. HRMS m/z (ESI): calcd for C$_{23}$H$_{24}$N$_3$ [M+H]$^+$: 342.1965, found: 342.1977.

7-methyl-4-(5-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2bc)
White solid (103.0 mg, 82% yield). Mp: 126 – 128 °C ¹H NMR (500 MHz, CDCl₃) δ 8.83 (s, 1H), 7.63 (d, J = 8.5 Hz, 1H), 7.18 – 7.14 (m, 2H), 7.14 – 7.09 (m, 3H), 7.06 (d, J = 2.6 Hz, 1H), 7.02 (dd, J = 8.5, 2.6 Hz, 1H), 6.90 (d, J = 3.5 Hz, 1H), 6.02 (d, J = 3.5 Hz, 1H), 3.89 (s, 3H), 3.77 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 160.3, 159.3, 151.3, 150.7, 142.7, 141.1, 132.3, 129.7, 129.1, 129.0, 128.0, 126.8, 117.5, 115.9, 113.0, 100.2, 55.4, 31.0. HRMS m/z (ESI): calcd for C₂₀H₁₈N₃O [M+H]⁺: 316.1444, found: 316.1447.

7-methyl-4-(5-carbonitrile-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2bd)

White solid (80.9 mg, 65% yield). Mp: 166 – 168 °C ¹H NMR (500 MHz, CDCl₃) δ 8.86 (s, 1H), 7.82 (s, 1H), 7.76 (d, J = 1.1 Hz, 2H), 7.16 – 7.09 (m, 5H), 6.98 (d, J = 3.6 Hz, 1H), 5.97 (d, J = 3.6 Hz, 1H), 3.80 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 157.2, 151.3, 150.8, 142.2, 141.2, 138.7, 134.1, 131.6, 130.6, 130.1, 128.8, 128.3, 127.6, 118.4, 117.1, 113.1, 99.5, 31.1. HRMS m/z (ESI): calcd for C₂₀H₁₄N₄Na [M+Na]⁺: 333.1111, found: 333.1111.

7-methyl-4-(5-(trifluoromethyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2be)
White solid (101.8 mg, 72% yield). Mp: 128–130 °C. 1H NMR (500 MHz, CDCl₃) δ 8.88 (s, 1H), 7.78 (t, J = 8.1 Hz, 2H), 7.73 (dd, J = 8.1, 1.1 Hz, 1H), 7.19–7.10 (m, 5H), 6.95 (d, J = 3.6 Hz, 1H), 6.01 (d, J = 3.6 Hz, 1H), 3.78 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 158.0, 151.3, 150.9, 141.8, 140.3, 139.6, 131.3 (J_C-F = 32.5 Hz), 131.3, 129.8, 129.0, 128.2, 127.4 (J_C-F = 3.8 Hz), 127.3, 124.0 (J_C-F = 3.7 Hz), 124.0 (J_C-F = 237.1 Hz), 117.3, 99.7, 31.0. HRMS m/z (ESI): calcd for C₂₀H₁₄F₃N₃Na [M+Na]⁺: 376.1032, found: 376.1034.

7-methyl-4-(5-fluoro-[1,1’-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2bf)

Yellow solid (93.1 mg, 77% yield). Mp: 108–110 °C. 1H NMR (500 MHz, CDCl₃) δ 8.84 (s, 1H), 7.64 (dd, J = 8.5, 5.8 Hz, 1H), 7.23 (dd, J = 9.7, 2.6 Hz, 1H), 7.16 (m, 1H), 7.14–7.08 (m, 5H), 6.92 (d, J = 3.5 Hz, 1H), 5.99 (d, J = 3.5 Hz, 1H), 3.77 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 163.0 (J_C-F = 249.3 Hz), 158.5, 151.3, 150.7, 143.3 (J_C-F = 8.0 Hz), 139.9, 133.0 (J_C-F = 3.0 Hz), 132.7 (J_C-F = 8.7 Hz), 129.4, 128.9, 128.1, 127.1, 117.4, 117.2 (J_C-F = 21.9 Hz), 114.3 (J_C-F = 21.3 Hz), 99.9, 31.0. HRMS m/z (ESI): calcd for C₁₉H₁₄F₃N₃Na [M+Na]⁺: 326.1064, found: 326.1068.

7-methyl-4-(5-chloro-[1,1’-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2bg)

Yellow solid (87.1 mg, 68% yield). Mp: 84–86 °C. 1H NMR (500 MHz, CDCl₃) δ 8.85 (s, 1H), 7.60 (d, J = 8.2 Hz, 1H), 7.53 (d, J = 2.1 Hz, 1H), 7.45 (dd, J = 8.2, 2.2 Hz, 1H), 7.12 (s, 5H), 6.93 (d, J = 3.6 Hz, 1H), 5.99 (d, J = 3.6 Hz, 1H), 3.78 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 158.3, 151.4, 150.8, 142.8, 139.7, 135.4, 135.2, 132.2, 130.5, 129.6, 129.0, 128.2, 127.5, 127.2, 117.4, 99.9, 31.1. HRMS m/z (ESI): calcd for C₁₉H₁₅ClN₃ [M+H]⁺: 320.0949, found: 320.0964.
7-methyl-4-(4-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2ca)

Yellow solid (115.8 mg, 92% yield). Mp: 130−132 °C  $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.88 (s, 1H), 7.44 (d, $J = 8.5$ Hz, 1H), 7.19 (d, $J = 2.7$ Hz, 1H), 7.13−7.03 (m, 6H), 6.89 (d, $J = 3.5$ Hz, 1H), 6.01 (d, $J = 3.5$ Hz, 1H), 3.85 (s, 3H), 3.75 (s, 3H).  $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 159.2, 158.7, 151.2, 150.6, 140.7, 137.8, 133.6, 131.7, 129.3, 129.0, 127.9, 126.1, 117.3, 115.5, 115.3, 100.1, 55.4, 30.9. HRMS m/z (ESI): calcd for C$_{20}$H$_{18}$N$_3$O [M+H]$^+$: 316.1444, found: 316.1458.

7-methyl-4-(4-(trifluoromethyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2cb)

White solid (104.1 mg, 74% yield). Mp: 141−143 °C $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.88 (s, 1H), 7.94 (d, $J = 1.7$ Hz, 1H), 7.78 (dd, $J = 8.1, 1.4$ Hz, 1H), 7.64 (d, $J = 8.1$ Hz, 1H), 7.17−7.11 (m, 5H), 6.94 (d, $J = 3.5$ Hz, 1H), 5.98 (d, $J = 3.5$ Hz, 1H), 3.78 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 157.8, 151.3, 150.8, 144.5, 139.6, 137.5, 131.0, 129.8, 129.6 ($J_{C-F} = 32.7$ Hz), 128.9, 128.2, 127.8 ($J_{C-F} = 3.9$ Hz), 127.4, 125.9 ($J_{C-F} = 3.8$ Hz), 124.0 ($J_{C-F} = 273.0$ Hz), 117.3, 99.6, 31.0. HRMS m/z (ESI): calcd for C$_{20}$H$_{14}$F$_3$N$_3$Na [M+Na]$^+$: 376.1032, found: 376.1036.

7-methyl-4-(4-carbonitrile-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2cc)
Yellow solid (85.6 mg, 69% yield). Mp: 159–161 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.86 (s, 1H), 7.96 (d, \(J = 1.7\) Hz, 1H), 7.81 (dd, \(J = 8.0, 1.8\) Hz, 1H), 7.64 (d, \(J = 8.0\) Hz, 1H), 7.18–7.11 (m, 5H), 6.98 (d, \(J = 3.6\) Hz, 1H), 5.98 (d, \(J = 3.6\) Hz, 1H), 3.81 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 156.9, 151.3, 150.9, 145.6, 139.2, 137.4, 134.5, 132.4, 131.4, 130.1, 128.8, 128.3, 127.8, 118.3, 117.2, 111.4, 99.5, 31.1. HRMS m/z (ESI): calcd for C\(_{20}\)H\(_{15}\)N\(_4\) [M+H]\(^+\): 311.1291, found: 311.1304.

7-methyl-4-(4-chloro-[1,1'-biphenyl]-2-yl)-7\(H\)-pyrrolo[2,3-\(d\)]pyrimidine (2cd)

Yellow solid (90.8 mg, 71% yield). Mp: 136–138 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.86 (s, 1H), 7.65 (d, \(J = 2.2\) Hz, 1H), 7.51–7.43 (m, 2H), 7.15–7.06 (m, 5H), 6.92 (d, \(J = 3.6\) Hz, 1H), 5.99 (d, \(J = 3.6\) Hz, 1H), 3.77 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 157.9, 151.2, 150.7, 139.8, 139.5, 138.3, 133.3, 131.8, 130.5, 129.6, 128.3, 128.1, 126.9, 117.2, 99.8, 31.0. HRMS m/z (ESI): calcd for C\(_{19}\)H\(_{15}\)ClN\(_3\) [M+H]\(^+\): 320.0949, found: 320.0952.

7-methyl-4-(3-methyl-[1,1'-biphenyl]-2-yl)-7\(H\)-pyrrolo[2,3-\(d\)]pyrimidine (2da)

Yellow viscous oil (95.3 mg, 80% yield). \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.87 (s, 1H), 7.41 (t, \(J = 7.6\) Hz, 1H), 7.31 (m, 2H), 7.14–7.07 (m, 2H), 7.04–6.99 (m, 3H), 6.94 (d, \(J = 3.6\) Hz, 1H), 6.03 (d, \(J = 3.6\) Hz, 1H), 3.78 (s, 3H), 2.11 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 159.7, 151.0, 150.7, 141.3, 136.6, 136.0, 129.4, 129.3, 129.0, 128.5, 127.6, 127.5, 126.3, 118.4, 99.8, 31.0, 20.1. HRMS m/z (ESI): calcd for C\(_{20}\)H\(_{17}\)N\(_3\)Na

7-methyl-4-(3-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2db)

White solid (112.0 mg, 89% yield). Mp: 169–170 °C 1H NMR (500 MHz, CDCl₃) δ 8.84 (s, 1H), 7.46 (t, J = 8.0 Hz, 1H), 7.12–7.06 (m, 3H), 7.06–6.99 (m, 4H), 6.93 (d, J = 3.5 Hz, 1H), 6.09 (d, J = 3.5 Hz, 1H), 3.75 (s, 3H), 3.71 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 157.3, 157.1, 150.8, 150.5, 142.9, 140.7, 129.7, 129.1, 128.9, 127.5, 126.4, 125.6, 122.5, 119.1, 110.0, 99.9, 55.8, 30.9. HRMS m/z (ESI): calcd for C₂₀H₁₇N₃ONa [M+Na]^+: 338.1264, found: 338.1266.

7-methyl-4-(3-(trifluoromethyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2dc)

Yellow viscous oil (81.8 mg, 58% yield). 1H NMR (500 MHz, CDCl₃) δ 8.85 (s, 1H), 7.86–7.80 (m, 1H), 7.67–7.60 (m, 2H), 7.10–7.04 (m, 2H), 7.04–6.99 (m, 3H), 6.96 (d, J = 3.5 Hz, 1H), 6.01 (d, J = 3.5 Hz, 1H), 3.77 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 156.6, 150.5, 150.4, 143.4, 139.6, 134.9, 133.7, 129.7, 129.4 (J_C-F = 30.7 Hz), 129.0, 128.8, 127.6, 127.0, 125.4 (J_C-F = 5.2 Hz), 123.8 (J_C-F = 275.0 Hz), 118.8, 99.6, 31.0. HRMS m/z (ESI): calcd for C₂₀H₁₅F₃N₃ [M+H]^+: 354.1213, found: 354.1229.

7-methyl-4-(3-fluoro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2dd)

Yellow viscous oil (88.1 mg, 73% yield). 1H NMR (500 MHz, CDCl₃) δ 8.83 (s, 1H),
7.46 (m, 1H), 7.29 (dd, J = 7.7, 1.0 Hz, 1H), 7.18 (m, 1H), 7.11–7.05 (m, 5H), 6.99 (d, J = 3.5 Hz, 1H), 6.15 (d, J = 3.5 Hz, 1H), 3.76 (s, 3H). 

13C NMR (126 MHz, CDCl₃) δ 160.2 (J_C-F = 248.9 Hz), 154.0, 150.8, 150.6, 143.5 (J_C-F = 2.6 Hz), 139.6 (J_C-F = 2.4 Hz), 130.2 (J_C-F = 9.0 Hz), 129.7, 128.8, 127.8, 126.8, 125.9 (J_C-F = 3.0 Hz), 124.5 (J_C-F = 15.6 Hz), 118.9, 114.5 (J_C-F = 22.3 Hz), 99.5, 30.8. HRMS m/z (ESI): calcd for C₁₉H₁₄FN₃Na [M+Na]⁺: 326.1064, found: 326.1068.

7-methyl-4-(4,5-difluoro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2e)

Yellow viscous oil (70.3 mg, 55% yield). ¹H NMR (500 MHz, CDCl₃) δ 8.79 (s, 1H), 7.40 (m, 1H), 7.29 (m, 1H), 7.17–7.12 (m, 5H), 6.97 (d, J = 3.6 Hz, 1H), 6.06 (d, J = 3.6 Hz, 1H), 3.79 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 157.4 (J_C-F = 2.5 Hz), 151.3 (dd, J_C-F = 251.7, 14.1 Hz), 151.1, 150.8, 148.0 (dd, J_C-F = 248.4, 13.0 Hz), 134.6 (J_C-F = 4.1 Hz), 132.7 (J_C-F = 2.4 Hz), 131.1 (J_C-F = 12.6 Hz), 130.2 (J_C-F = 1.7 Hz), 129.7, 127.9, 127.7, 126.2 (dd, J_C-F = 7.1, 4.2 Hz), 117.5, 116.1 (J_C-F = 17.4 Hz), 99.7, 31.1. HRMS m/z (ESI): calcd for C₁₉H₁₃F₂N₃Na [M+Na]⁺: 344.0970, found: 344.0977.

7-methyl-4-(2-phenynaphthalen-1-yl)-7H-pyrrolo[2,3-d]pyrimidine (2f)

White solid (108.3 mg, 81% yield). Mp: 49–51 °C ¹H NMR (500 MHz, CDCl₃) δ 9.00 (s, 1H), 8.02 (d, J = 8.5 Hz, 1H), 7.93 (d, J = 8.1 Hz, 1H), 7.64 (d, J = 8.5 Hz, 1H), 7.49–7.44 (m, 2H), 7.39–7.35 (m, 1H), 7.24–7.20 (m, 2H), 7.12–7.06 (m, 3H), 6.92 (d, J = 3.5 Hz, 1H), 5.93 (d, J = 3.5 Hz, 1H), 3.80 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 158.7, 151.0, 150.8, 141.3, 138.8, 132.8, 132.7, 131.8, 129.5, 129.3, 129.1, 128.0, 127.9, 127.7, 126.7, 126.5, 126.0, 125.9, 119.4, 99.9, 31.0. HRMS m/z (ESI): calcd for C₂₃H₁₈N₃ [M+H]⁺: 336.1495, found: 336.1500.
7-methyl-4-(3-phenylthiophen-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (2g)

White solid (85.2 mg, 73% yield). Mp: 134−136 °C 1H NMR (500 MHz, CDCl₃) δ 8.89 (s, 1H), 7.55 (d, J = 5.1 Hz, 1H), 7.31−7.30 (m, 1H), 7.29 (d, J = 2.2 Hz, 1H), 7.25−7.21 (m, 4H), 6.81 (d, J = 3.6 Hz, 1H), 5.58 (d, J = 3.6 Hz, 1H), 3.76 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 152.2, 151.5, 151.2, 141.7, 136.7, 136.6, 130.8, 129.1, 128.9, 128.5, 128.4, 127.3, 115.4, 100.9, 31.0. HRMS m/z (ESI): calcd for C₁₇H₁₃N₃SNa [M+Na]⁺: 314.0722, found: 314.0730.

7-methyl-4-(4'-methyl-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (3aa)

White solid (98.0 mg, 82% yield). Mp: 151−153 °C 1H NMR (500 MHz, CDCl₃) δ 8.86 (s, 1H), 7.63 (d, J = 7.4 Hz, 1H), 7.51 (d, J = 4.0 Hz, 2H), 7.44 (m, 1H), 7.04 (d, J = 8.1 Hz, 2H), 6.95−6.88 (m, 3H), 6.05 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H), 2.21 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 159.8, 151.3, 150.7, 141.1, 138.1, 136.8, 136.2, 130.7, 130.6, 129.3, 129.3, 129.0, 128.8, 127.1, 117.5, 100.2, 31.0, 21.1. HRMS m/z (ESI): calcd for C₂₀H₁₇N₃Na [M+Na]⁺: 322.1315, found: 322.1320.

7-methyl-4-(4'-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (3ab)

Yellow solid (110.8 mg, 88% yield). Mp: 122−124 °C 1H NMR (500 MHz, CDCl₃) δ 8.87 (s, 1H), 7.62 (dt, J = 7.6, 1.0 Hz, 1H), 7.53−7.48 (m, 2H), 7.46−7.41 (m, 1H), 7.11−7.03 (m, 2H), 6.92 (d, J = 3.6 Hz, 1H), 6.68−6.61 (m, 2H), 6.03 (d, J = 3.6 Hz, 1H), 3.79 (s, 3H), 3.69 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 159.8, 158.4, 151.4, 150.7, 140.6, 136.8, 133.5, 130.7, 130.4, 130.1, 129.3, 129.2, 126.9, 117.4, 113.5, 100.2,
55.1, 31.0. HRMS m/z (ESI): calcd for C_{20}H_{18}N_{3}O [M+H]^+: 316.1444, found: 316.1459.

7-methyl-4-(4'-(tert-butyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\(d\)]pyrimidine (3ac)

![Chemical structure of 7-methyl-4-(4'-(tert-butyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\(d\)]pyrimidine (3ac)](image)

White solid (125.3 mg, 92% yield). Mp: 129−131 °C. 1H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.88 (s, 1H), 7.66 (dd, \(J = 7.5, 1.4\) Hz, 1H), 7.56−7.47 (m, 2H), 7.44 (td, \(J = 7.4, 1.6\) Hz, 1H), 7.15−7.10 (m, 2H), 7.10−7.05 (m, 2H), 6.87 (d, \(J = 3.6\) Hz, 1H), 6.05 (d, \(J = 3.6\) Hz, 1H), 3.75 (s, 3H), 1.21 (s, 9H). 13C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 159.6, 151.1, 150.6, 149.3, 140.9, 137.8, 136.7, 130.6, 130.4, 129.1, 129.0, 128.6, 126.9, 124.7, 117.4, 100.1, 34.1, 31.1, 30.8. HRMS m/z (ESI): calcd for C\(_{23}\)H\(_{24}\)N\(_3\) [M+H]^+: 342.1965, found: 342.1981.

7-methyl-4-(4'-chloro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\(d\)]pyrimidine (3af)

![Chemical structure of 7-methyl-4-(4'-chloro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\(d\)]pyrimidine (3af)](image)

Black solid (80.8 mg, 65% yield). Mp: 175−177 °C. 1H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.84 (s, 1H), 7.68−7.62 (m, 1H), 7.56−7.45 (m, 3H), 7.09−7.04 (m, 4H), 6.97 (d, \(J = 3.5\) Hz, 1H), 6.05 (d, \(J = 3.5\) Hz, 1H), 3.80 (s, 3H). 13C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 159.1, 151.3, 150.8, 139.8, 139.5, 136.8, 132.7, 130.7, 130.3, 130.3, 129.5, 129.3, 128.1, 127.6, 117.4, 99.9, 31.0. HRMS m/z (ESI): calcd for C\(_{19}\)H\(_{15}\)ClN\(_3\) [M+H]^+: 320.0949, found: 320.0964.

7-methyl-4-(4'-fluoro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\(d\)]pyrimidine (3ag)

![Chemical structure of 7-methyl-4-(4'-fluoro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\(d\)]pyrimidine (3ag)](image)
White solid (102.6 mg, 85% yield). Mp: 177−179 °C. 1H NMR (500 MHz, CDCl₃) δ 8.85 (s, 1H), 7.67−7.61 (m, 1H), 7.55−7.43 (m, 3H), 7.13−7.05 (m, 2H), 6.94 (d, J = 3.5 Hz, 1H), 6.83−6.75 (m, 2H), 6.02 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 161.7 (J_C-F = 246.6 Hz), 159.2, 151.3, 150.8, 140.0, 137.0 (J_C-F = 3.4 Hz), 136.9, 130.6, 130.6, 130.5, 130.4, 129.3 (J_C-F = 18.3 Hz), 127.4, 117.4, 114.8 (J_C-F = 21.5 Hz), 99.9, 31.0. HRMS m/z (ESI): calcd for C₁₉H₁₄FN₃Na [M+Na]⁺: 326.1064, found: 326.1065.

Yellow solid (117.3 mg, 81% yield). Mp: 60−62 °C. 1H NMR (500 MHz, CDCl₃) δ 8.92 (s, 1H), 7.70 (dd, J = 7.5, 1.4 Hz, 1H), 7.62−7.54 (m, 2H), 7.54–7.48 (m, 3H), 7.41–7.35 (m, 4H), 7.29 (t, J = 7.3 Hz, 1H), 7.26−7.22 (m, 2H), 6.92 (d, J = 3.6 Hz, 1H), 6.11 (d, J = 3.5 Hz, 1H), 3.77 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 159.4, 151.2, 150.7, 140.6, 140.3, 140.0, 139.1, 136.8, 130.7, 130.5, 129.4, 129.4, 129.3, 128.6, 127.4, 127.1, 126.7, 126.5, 117.4, 100.1, 30.9. HRMS m/z (ESI): calcd for C₂₅H₂₀N₃ [M+H]⁺: 362.1652, found: 362.1642.

Yellow viscous oil (75.8 mg, 60% yield). 1H NMR (500 MHz, CDCl₃) δ 8.87 (s, 1H), 7.65–7.62 (m, 1H), 7.56–7.50 (m, 2H), 7.50–7.45 (m, 1H), 7.02 (t, J = 7.9 Hz, 1H), 6.92 (d, J = 3.6 Hz, 1H), 6.78–6.74 (m, 1H), 6.70–6.68 (m, 1H), 6.66–6.62 (m, 1H), 6.05 (d, J = 3.6 Hz, 1H), 3.78 (s, 3H), 3.53 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 159.5, 159.0, 151.2, 150.6, 142.3, 140.9, 136.9, 130.6, 130.3, 129.3, 129.2, 128.9, 127.4, 121.6, 117.5, 114.4, 112.8, 100.0, 54.9, 31.0. HRMS m/z (ESI): calcd for C₂₀H₁₈N₂O [M+H]⁺: 316.1444, found: 316.1453.
7-methyl-4-(2'-methyl-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-α]pyrimidine (3ca)

Yellow solid (66.0 mg, 55% yield). Mp: 115−117 °C. 1H NMR (500 MHz, CDCl₃) δ 8.77 (s, 1H), 7.67 (dd, J = 6.9, 2.2 Hz, 1H), 7.54−7.47 (m, 2H), 7.41−7.38 (m, 1H), 7.09 (dd, J = 7.5, 1.5 Hz, 1H), 7.07−7.01 (m, 1H), 7.01−6.94 (m, 3H), 6.18 (d, J = 3.6 Hz, 1H), 3.79 (s, 3H), 2.02 (s, 3H).

13C NMR (126 MHz, CDCl₃) δ 159.4, 151.1, 150.9, 140.9, 140.7, 137.8, 135.7, 131.0, 130.4, 130.2, 129.7, 129.1, 128.8, 127.2, 126.9, 125.1, 117.3, 100.0, 31.0, 20.3. HRMS m/z (ESI): calcd for C₂₀H₁₈N₃ [M+H]⁺: 300.1495, found: 300.1509.

7-methyl-4-(2'-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-α]pyrimidine (3cb)

White solid (81.8 mg, 65% yield). Mp: 129−131 °C. 1H NMR (500 MHz, CDCl₃) δ 8.80 (s, 1H), 7.70 (d, J = 7.7 Hz, 1H), 7.55−7.50 (m, 2H), 7.50−7.45 (m, 1H), 7.19 (dd, J = 7.5, 1.7 Hz, 1H), 7.12 (td, J = 7.9, 1.8 Hz, 1H), 6.93 (d, J = 3.5 Hz, 1H), 6.84 (td, J = 7.4, 1.1 Hz, 1H), 6.59 (dd, J = 8.3, 1.1 Hz, 1H), 6.20 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H), 3.23 (s, 3H). 13C NMR (126 MHz, CDCl₃) δ 159.9, 155.8, 151.0, 150.7, 137.8, 137.6, 131.4, 131.4, 130.1, 130.0, 128.9, 128.8, 128.5, 127.2, 120.5, 116.8, 110.3, 100.2, 54.5, 31.0. HRMS m/z (ESI): calcd for C₂₀H₁₈N₃ONa [M+Na]⁺: 338.1264, found: 338.1265.

7-methyl-4-(2'-chloro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-α]pyrimidine (3cd)

Yellow solid (88.4 mg, 69% yield). Mp: 147−149 °C. 1H NMR (500 MHz, CDCl₃) δ
8.77 (s, 1H), 7.74–7.69 (m, 1H), 7.55–7.47 (m, 3H), 7.23 (dd, J = 7.9, 1.3 Hz, 1H), 7.09–7.02 (m, 2H), 7.00–6.95 (m, 2H), 6.33 (d, J = 3.6 Hz, 1H), 3.77 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$158.8, 150.9, 150.8, 139.6, 138.3, 137.7, 132.7, 132.1, 131.3, 130.2, 129.3, 128.6, 128.1, 127.9, 126.1, 117.4, 99.8, 31.0. HRMS m/z (ESI): calcd for C$_{19}$H$_{15}$ClN$_3$ [M+H]$^+$: 320.0949, found: 320.0960.

7-methyl-4-(2'-fluoro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (3ce)

Yellow viscous oil (103.2 mg, 85% yield). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$8.80 (s, 1H), 7.74–7.70 (m, 1H), 7.55–7.50 (m, 3H), 7.12–7.06 (m, 2H), 6.97 (d, J = 3.5 Hz, 1H), 6.90 (td, J = 7.5, 1.2 Hz, 1H), 6.87–6.83 (m, 1H), 6.22 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$159.3 ($J_{C,F}$ = 247.1 Hz), 158.9, 151.1, 150.8, 137.7, 134.9, 131.8 ($J_{C,F}$ = 3.4 Hz), 131.3 ($J_{C,F}$ = 1.3 Hz), 130.3, 129.3, 128.9, 128.8, 128.7, 127.9, 123.7 ($J_{C,F}$ = 3.6 Hz), 117.1, 115.3 ($J_{C,F}$ = 22.5 Hz), 99.7, 30.9. HRMS m/z (ESI): calcd for C$_{19}$H$_{15}$FN$_3$ [M+H]$^+$: 304.1245, found: 304.1259.

7-methyl-4-(3',4'-difluoro-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (3d)

Yellow solid (68.3 mg, 53% yield). Mp: 133–135 °C $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.85 (s, 1H), 7.65 (dd, J = 7.5, 1.5 Hz, 1H), 7.56–7.44 (m, 3H), 7.03–6.95 (m, 2H), 6.92–6.85 (m, 1H), 6.84–6.79 (m, 1H), 6.08 (d, J = 3.5 Hz, 1H), 3.82 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$158.8, 151.3, 150.9, 149.8 (dd, $J_{C,F}$ = 248.4, 12.8 Hz), 149.3 (dd, $J_{C,F}$ = 248.6, 12.7 Hz), 139.0, 138.1 (dd, $J_{C,F}$ = 6.1, 3.9 Hz), 136.9, 130.8, 130.3, 129.7, 129.4, 127.9, 125.2 (dd, $J_{C,F}$ = 6.1, 3.6 Hz), 117.9 ($J_{C,F}$ = 17.5 Hz), 117.4, 116.7 ($J_{C,F}$ = 17.2 Hz), 99.8, 31.0. HRMS m/z (ESI): calcd for C$_{19}$H$_{13}$F$_2$N$_3$Na [M+Na]$^+$: 344.0970, found: 344.0976.

7-methyl-4-(2-(naphthalen-1-yl)phenyl)-7H-pyrrolo[2,3-d]pyrimidine (3e)
Black viscous oil (75.1 mg, 56% yield). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.70 (s, 1H), 7.86 (d, $J = 8.3$ Hz, 1H), 7.80–7.75 (m, 1H), 7.72 (d, $J = 8.0$ Hz, 1H), 7.63 (dd, $J = 6.2$, 3.4 Hz, 1H), 7.60–7.57 (m, 3H), 7.36–7.29 (m, 2H), 7.25–7.20 (m, 2H), 6.77 (d, $J = 3.5$ Hz, 1H), 6.01 (d, $J = 3.5$ Hz, 1H), 3.66 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 159.2, 150.9, 150.5, 139.4, 138.6, 138.4, 133.4, 132.0, 131.7, 130.5, 129.1, 128.8, 128.0, 128.0, 127.6, 127.3, 126.0, 125.7, 125.4, 124.9, 117.4, 100.0, 30.9. HRMS m/z (ESI): calcd for C$_{23}$H$_{18}$N$_3$ [M+H]$^+$: 336.1495, found: 336.1510.

7-methyl-4-(2-(thiophen-2-yl)phenyl)-7H-pyrrolo[2,3-d]pyrimidine (3f)

Black viscous oil (73.2 mg, 63% yield). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.94 (s, 1H), 7.65–7.58 (m, 2H), 7.53–7.43 (m, 2H), 7.09 (dd, $J = 5.1$, 1.2 Hz, 1H), 7.00 (d, $J = 3.5$ Hz, 1H), 6.73 (dd, $J = 5.1$, 3.6 Hz, 1H), 6.64 (dd, $J = 3.6$, 1.2 Hz, 1H), 6.13 (d, $J = 3.5$ Hz, 1H), 3.83 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 158.9, 151.1, 150.7, 142.3, 136.3, 133.5, 130.7, 130.6, 129.8, 129.4, 127.7, 127.1, 126.9, 125.6, 117.8, 100.0, 31.1. HRMS m/z (ESI): calcd for C$_{17}$H$_{13}$N$_3$SNa [M+Na]$^+$: 314.0722, found: 314.0726.

7-methyl-4-(2-(thiophen-3-yl)phenyl)-7H-pyrrolo[2,3-d]pyrimidine (3g)

Yellow solid (93.2 mg, 80% yield). Mp: 126–128 °C $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.91 (s, 1H), 7.61 (dd, $J = 7.6$, 1.5 Hz, 1H), 7.56 (dd, $J = 7.6$, 1.5 Hz, 1H), 7.48 (td, $J = 7.5$, 1.6 Hz, 1H), 7.43 (td, $J = 7.4$, 1.4 Hz, 1H), 7.03–6.96 (m, 2H), 6.94 (d, $J = 3.5$ Hz, 1H), 6.70 (dd, $J = 4.5$, 1.8 Hz, 1H), 6.05 (d, $J = 3.5$ Hz, 1H), 3.79 (s, 3H). $^{13}$C
NMR (126 MHz, CDCl$_3$) $\delta$ 159.3, 151.3, 150.7, 141.3, 136.7, 135.5, 130.5, 129.9, 129.3, 129.2, 128.3, 127.2, 124.8, 122.7, 117.4, 99.8, 30.9. HRMS m/z (ESI): calcd for C$_{17}$H$_{13}$N$_3$SNa [M+Na]$^+$: 314.0722, found: 314.0722.

7-methyl-4-(3-(4-(tert-butyl)phenyl)thiophen-2-yl)-7H-pyrrolo[2,3-\textit{d}]pyrimidine (3h)

Yellow solid (95.6 mg, 69% yield). Mp: 147–149 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.90 (s, 1H), 7.55 (d, $J$ = 5.1 Hz, 1H), 7.28–7.23 (m, 5H), 6.78 (d, $J$ = 3.6 Hz, 1H), 5.55 (d, $J$ = 3.6 Hz, 1H), 3.79 (s, 3H), 1.29 (s, 9H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 152.5, 151.6, 151.3, 150.4, 141.9, 136.6, 133.8, 130.9, 128.8, 128.7, 128.3, 125.5, 115.5, 101.2, 34.5, 31.3, 31.1. HRMS m/z (ESI): calcd for C$_{21}$H$_{21}$N$_3$SNa [M+Na]$^+$: 370.1348, found: 370.1349.

7-methyl-4-(4'-(tert-butyl)-3-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\textit{d}]pyrimidine (3i)

Yellow viscous oil (126.5 mg, 85% yield). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.82 (s, 1H), 7.44 (t, $J$ = 8.0 Hz, 1H), 7.09 (dd, $J$ = 7.7, 1.0 Hz, 1H), 7.07–7.02 (m, 2H), 7.02–6.97 (m, 3H), 6.94 (d, $J$ = 3.5 Hz, 1H), 6.12 (d, $J$ = 3.5 Hz, 1H), 3.78 (s, 3H), 3.71 (s, 3H), 1.18 (s, 9H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 157.3, 157.3, 150.8, 150.5, 149.2, 142.8, 137.6, 129.7, 129.0, 128.5, 125.6, 124.4, 122.7, 119.3, 109.8, 100.0, 55.8, 34.2, 31.1, 30.8. HRMS m/z (ESI): calcd for C$_{24}$H$_{26}$N$_3$O [M+H]$^+$: 372.2070, found: 372.2074.

7-methyl-4-(4'-(tert-butyl)-4-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-\textit{d}]pyrimidine (3j)
Yellow viscous oil (137.8 mg, 93% yield). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.86 (s, 1H), 7.43 (d, $J = 8.5$ Hz, 1H), 7.18 (d, $J = 2.7$ Hz, 1H), 7.08 (d, $J = 8.4$ Hz, 2H), 7.04 (dd, $J = 8.5$, 2.7 Hz, 1H), 7.01 (d, $J = 8.4$ Hz, 2H), 6.85 (d, $J = 3.6$ Hz, 1H), 6.00 (d, $J = 3.6$ Hz, 1H), 3.83 (s, 3H), 3.74 (s, 3H), 1.18 (s, 9H).

$^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 159.3, 158.5, 151.1, 150.6, 148.8, 137.7, 137.5, 133.5, 131.6, 129.0, 128.5, 124.6, 117.3, 115.4, 115.3, 100.1, 55.2, 34.0, 31.0, 30.7. HRMS m/z (ESI): calcd for C$_{24}$H$_{26}$N$_3$O $[M+H]^+$: 372.2070, found: 372.2075.

7-methyl-4-(4'-(tert-butyl)-5-methoxy-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-$d$]pyrimidine (3k)

Yellow solid (127.8 mg, 86% yield). Mp: 148−150 °C $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.82 (s, 1H), 7.62 (d, $J = 8.5$ Hz, 1H), 7.18−7.11 (m, 2H), 7.11−7.04 (m, 3H), 7.00 (dd, $J = 8.5$, 2.6 Hz, 1H), 6.88 (d, $J = 3.5$ Hz, 1H), 6.02 (d, $J = 3.5$ Hz, 1H), 3.90 (s, 3H), 3.79 (s, 3H), 1.22 (s, 9H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 160.2, 159.5, 151.3, 150.7, 149.7, 142.7, 138.0, 132.3, 129.7, 128.7, 128.7, 124.9, 117.5, 115.8, 112.8, 100.4, 55.4, 34.3, 31.2, 31.0. HRMS m/z (ESI): calcd for C$_{24}$H$_{26}$N$_3$O $[M+H]^+$: 372.2070, found: 372.2074.

7-methyl-4-(4'-(tert-butyl)-3-(trifluoromethyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-$d$]pyrimidine (3l)
Yellow solid (98.3 mg, 60% yield). Mp: 58–60 °C ¹H NMR (500 MHz, CDCl₃) δ 8.85 (s, 1H), 7.81 (dd, J = 6.9, 2.3 Hz, 1H), 7.67–7.59 (m, 2H), 7.05–7.00 (m, 2H), 6.99–6.94 (m, 3H), 6.02 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H), 1.16 (s, 9H). ¹³C NMR (126 MHz, CDCl₃) δ 156.8, 150.5, 150.4, 149.9, 143.4, 136.6, 133.8, 129.6, 129.2 (J_C-F = 7.5 Hz), 128.8, 128.7, 125.2 (J_C-F = 5.3 Hz), 124.5, 123.9 (J_C-F = 274.7 Hz), 119.0, 116.0, 99.8, 34.3, 31.1, 30.9. HRMS m/z (ESI): calcd for C₂₄H₂₃F₃N₃ [M+H]^+: 410.1839, found: 410.1857.

7-methyl-4-(4'-(tert-butyl)-4-(trifluoromethyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-α]pyrimidine (3m)

Yellow solid (113.2 mg, 69% yield). Mp: 58–60 °C ¹H NMR (500 MHz, CDCl₃) δ 8.88 (s, 1H), 7.94 (d, J = 1.9 Hz, 1H), 7.76 (dd, J = 8.1, 1.9 Hz, 1H), 7.65 (d, J = 8.1 Hz, 1H), 7.19–7.13 (m, 2H), 7.10–7.04 (m, 2H), 6.93 (d, J = 3.6 Hz, 1H), 5.98 (d, J = 3.6 Hz, 1H), 3.80 (s, 3H), 1.21 (s, 9H). ¹³C NMR (126 MHz, CDCl₃) δ 158.0, 151.3, 150.9, 150.5, 144.5, 137.5, 136.6, 131.0, 129.6, 129.3 (J_C-F = 32.8 Hz), 128.7, 127.8 (J_C-F = 3.9 Hz), 125.8 (J_C-F = 3.9 Hz), 125.1, 124.1 (J_C-F = 272.5 Hz), 117.4, 99.8, 34.3, 31.1, 30.9. HRMS m/z (ESI): calcd for C₂₄H₂₂F₃N₃Na [M+Na]^+: 432.1658, found: 432.1658.

7-methyl-4-(4'-(tert-butyl)-5-(trifluoromethyl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-α]pyrimidine (3n)
Yellow solid (102.8 mg, 63% yield). Mp: 125–127 °C \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.88 (s, 1H), 7.80 (s, 1H), 7.77 (d, \(J = 8.0\) Hz, 1H), 7.71 (dd, \(J = 8.2, 1.8\) Hz, 1H), 7.19–7.13 (m, 2H), 7.10–7.05 (m, 2H), 6.97 (d, \(J = 3.6\) Hz, 1H), 6.03 (d, \(J = 3.6\) Hz, 1H), 3.83 (s, 3H), 1.22 (s, 9H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 158.2, 151.4, 150.9, 150.4, 141.9, 140.2, 136.7, 131.3 (\(J_{C-F} = 32.6\) Hz), 131.3, 129.6, 128.7, 127.5 (\(J_{C-F} = 3.9\) Hz), 125.2, 124.1 (\(J_{C-F} = 273.1\) Hz), 123.8 (\(J_{C-F} = 3.9\) Hz), 117.5, 100.0, 34.4, 31.2, 31.1. HRMS m/z (ESI): calcd for C\(_{24}\)H\(_{23}\)F\(_3\)N\(_3\) [M+H]\(^+\): 410.1839, found: 410.1844.

7-methyl-4-((1,1′:3′,1″-terphenyl)-2′-yl)-7\(^H\)-pyrrolo[2,3-\(d\)]pyrimidine (4a)

White solid (76.8 mg, 53% yield). Mp: 151–153 °C \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.61 (s, 1H), 7.57 (dd, \(J = 8.3, 7.0\) Hz, 1H), 7.48 (d, \(J = 7.4\) Hz, 2H), 7.11–7.06 (m, 4H), 7.06–7.02 (m, 6H), 6.84 (d, \(J = 3.5\) Hz, 1H), 6.00 (d, \(J = 3.5\) Hz, 1H), 3.68 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 159.0, 150.4, 150.2, 142.0, 141.1, 135.2, 129.4, 129.3, 128.9, 128.7, 127.5, 126.4, 119.3, 99.7, 30.8. HRMS m/z (ESI): calcd for C\(_{25}\)H\(_{20}\)N\(_3\) [M+H]\(^+\): 362.1652, found: 362.1660.

7-methyl-4-(4-(tert-butyl)-[1,1′:3′,1″-terphenyl]-2′-yl)-7\(^H\)-pyrrolo[2,3-\(d\)]pyrimidine (4b)

Yellow solid (98.5 mg, 59% yield). Mp: 159–161 °C \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.62 (s, 1H), 7.55 (t, \(J = 7.6\) Hz, 1H), 7.49 (dd, \(J = 7.7, 1.4\) Hz, 1H), 7.46 (dd, \(J = 7.6, 1.4\) Hz, 1H), 7.11–7.06 (m, 3H), 7.06–7.05 (m, 1H), 7.05–7.01 (m, 3H), 7.01–6.97 (m, 2H), 6.82 (d, \(J = 3.5\) Hz, 1H), 5.99 (d, \(J = 3.5\) Hz, 1H), 3.68 (s, 3H), 1.20 (s, 9H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 159.1, 150.3, 150.2, 149.2, 142.0, 142.0, 141.2, 138.1, 135.0, 129.5, 129.2, 129.0, 128.7, 128.6, 127.5, 126.4, 124.4, 119.3, 100.0, 34.2, 31.2, 30.8. HRMS m/z (ESI): calcd for C\(_{29}\)H\(_{27}\)N\(_3\)Na [M+Na]\(^+\): 440.2097, found: 440.2098.
7-methyl-4-(3-(thiophen-3-yl)-[1,1'-biphenyl]-2-yl)-7H-pyrrolo[2,3-d]pyrimidine (4c)

Yellow solid (98.5 mg, 59% yield). Mp: 156–158 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.61 (s, 1H), 7.60 (dd, J = 7.4, 1.6 Hz, 1H), 7.51 (dd, J = 7.6, 1.5 Hz, 1H), 7.50–7.42 (m, 2H), 7.14 (d, J = 5.2 Hz, 1H), 7.06–6.99 (m, 3H), 6.97 (d, J = 5.1 Hz, 1H), 6.88 (d, J = 3.6 Hz, 1H), 6.85–6.79 (m, 2H), 6.01 (d, J = 3.6 Hz, 1H), 3.79 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 158.8, 150.9, 150.9, 139.6, 137.7, 136.8, 135.8, 134.0, 131.3, 131.2, 130.8, 129.2, 128.9, 128.3, 128.1, 127.5, 127.1, 123.8, 117.1, 99.8, 31.0. HRMS m/z (ESI): calcd for C₂₃H₁₈N₃S [M+H]^+: 368.1216, found: 368.1220.
5. NMR Spectra of Compounds
6. Single Crystal X-ray Diffraction Data for Compounds 3ac

Figure S1. X-ray crystal structure of 3ac.
### Table S2. Crystal data and structure refinement for 3ac.

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S = 1.051 | Npar= 239